Monitoring Series **No. 1**

California Rangelands Research and Information Center

Types of Monitoring*

The term "monitor" is defined as to watch or check. Although it is not an explicit part of the definition, the term *monitoring suggests a series of observations over time*. This repetition of measurements over time for the purpose of detecting change distinguishes monitoring from inventory and assessment. While both inventories and assessments can be based on a single measurement or observation, they also can incorporate a series of observations to obtain a better estimate of a particular parameter. For example, the number of species of fish in a particular reach might be counted as part of an inventory of fish species, and several counts might be made in order to obtain a more accurate estimate. Similarly, maximum daily water temperature might be measured several times over the course of a summer to assess whether summer temperatures might be an important limitation to the quality of fish habitat under the existing conditions. However, if water temperatures are measured over several years to determine the effect of upstream management activities or climatic variations, this is clearly monitoring. The overlap in the definitions of assessment, inventory, and monitoring means that in some cases the primary distinguishing feature of monitoring will be the intent to assess change rather than the number or type of measurements.

Often an *assessment or inventory serves as the first step towards establishing a monitoring project*. Knowledge of the spatial and temporal variability is essential to developing an efficient monitoring plan. Inventory and assessment techniques overlap with monitoring procedures.

A number of federal and state agencies have defined the different types of monitoring carried out by their particular organization. Unfortunately, these definitions are not consistent, and this has often resulted in semantic confusion. In most cases *a clear statement of the purpose of the monitoring will be the best method of defining the type of monitoring*, and it then is simply a matter of attaching a mutually agreeable label to that particular type of monitoring.

It should be emphasized that the following *seven* types of monitoring are not mutually exclusive. Often the distinction between them is determined more by the purpose of monitoring than by the type and intensity of measurements. Regular sampling of coliform bacteria to meet health standards, for example, will produce data that also can be used to indicate long-term trends. The following table describes monitoring types according to the parameters being measured, the frequency of monitoring, the duration of monitoring, and the intensity of data analysis. At this point no consensus exists on the definitions of monitoring types, and this, together with the proliferation of monitoring terminology, means that each monitoring plan should explicitly define the monitoring terminology being used.

Most water quality monitoring projects will involve more than one type of monitoring. Distinct objectives attained through different types of monitoring do not necessarily require distinct and independent collection efforts. There is often considerable overlap in terms of data needs, and recognition of this can result in cost savings.

General Characteristics of Monitoring Types				
Type of Monitoring	Number and Type of Water Quality Parameters	Frequency of Measurements	Duration of Monitoring	Intensity of Data Analysis
Trend	Usually water column	Low	Long	Low to moderate
Baseline	Variable	Low	Short to medium	Low to moderate
Implementation	None	Variable	Duration of project	Low
Effectiveness	Near activity	Medium to high	Usually short to medium	Medium
Project	Variable	Medium to high	> Project duration	Medium
Validation	Few	High	Usually medium to long	High
Compliance	Few	Variable	Dependent on project	Moderate to high

1. *Trend monitoring*. In view of the definition of monitoring, this term is redundant. Use of the adjective "trend" implies that measurements will be made at regular, well-spaced time intervals in order to determine the long-term trend in a particular parameter. Typically, the observations are not taken specifically to evaluate management practices (as in type 4), management activities (as in type 5), water quality models (as in type 6), or water quality standards (as in type 7), although trend data may be utilized for one or all of these other purposes.

2. *Baseline monitoring*. Baseline monitoring is used to characterize existing water quality conditions and to establish a data base for planning or future comparisons. The intent of baseline monitoring is to capture much of the temporal variability of the constituent(s) of interest, but there is no explicit end point at which continued baseline monitoring becomes trend monitoring. Those who prefer the terms "inventory monitoring" and "assessment monitoring" often define them such that they are essentially synonymous with baseline monitoring. Others use baseline monitoring to refer to longterm trend monitoring on major streams.

3. *Implementation monitoring.* This type of monitoring assesses whether activities were carried out as planned. The most common use of implementation monitoring is to determine whether Best Management Practices (BMPs) were implemented as specified in an environmental assessment, environmental impact statement, other planning document, or contract. Typically, this is carried out as an administrative review and does not involve any water quality measurements. Implementation monitoring is one of the few terms which has a relatively widespread and consistent definition. Many believe that implementation monitoring is the most cost-effective means to reduce nonpoint source pollution because it provides immediate feedback to the managers on whether the BMP process is being carried out as intended. On its own, however, implementation monitoring cannot directly link management activities to water quality, as no water quality measurements are being made.

4. *Effectiveness monitoring*. While implementation monitoring is used to assess whether a particular activity was carried out as planned, effectiveness monitoring is used to evaluate whether the specified activities had the desired effect. Confusion arises over whether effectiveness monitoring should be limited to

evaluating individual BMPs or whether it also can be used to evaluate the total effect of an entire set of practices. The problem with this broader definition is that the distinction between effectiveness monitoring and other terms, such as project or compliance monitoring, becomes blurred.

Monitoring the effectiveness of individual BMPs, such as the spacing of water bars on skid trails, is an important part of the overall process of controlling nonpoint source pollution. However, in most cases the monitoring of individual BMPs is quite different from monitoring to determine whether the cumulative effect of all the BMPs results in adequate water quality protection. Evaluating individual BMPs may require detailed and specialized measurements best made at the site of, or immediately adjacent to, the management practice. Thus, effectiveness monitoring often occurs outside of the stream channel and riparian area, even though the objective of a particular practice is intended to protect the designated uses of a water body. In contrast, monitoring the overall effectiveness of BMPs usually is done in the stream channel, and it may be difficult to relate these measurements to the effectiveness of individual BMPs.

5. *Project monitoring*. This type of monitoring assesses the impact of a particular activity or project, such as a timber sale or construction of a ski run on water quality. Often this assessment is done by comparing data taken upstream and downstream of the particular project, although in some cases, such as a fish habitat improvement project, the comparison may be on a before and after basis. Because such comparisons may, in part, indicate the overall effectiveness of the BMPs and other mitigation measures associated with the project, some agencies consider project monitoring to be a subset of effectiveness monitoring. Again, the problem is that water quality is a function of more than the effectiveness of the BMPs associated with the project.

6. *Validation monitoring*. This refers to the quantitative evaluation of proposed water quality model. The data set used for validation should be different from the data set used to construct and calibrate the model. This separation helps ensure that the validation data will provide an unbiased evaluation of the overall performance of the model. The intensity and type of sampling for validation monitoring should be consistent with the output of the model being validated.

7. *Compliance monitoring*. This is the monitoring used to determine whether specified water quality criteria are being met. The criteria can be numerical or descriptive. Usually the regulations associated with individual criterion specify the location, frequency, and method of measurement.

Monitoring Concepts for Rangeland Management**

Short-term Monitoring

Short-term monitoring involves collecting and recording vegetation and other resource characteristic information **within a year**, mainly for day-to-day and annual management decisions. Short-term monitoring focuses on such questions as: Is the grazing occurring as planned? Are there outside influences on the vegetation? What changes should be made now or next year to better meet management objectives? Short-term monitoring also provides essential information for interpreting long-term monitoring studies.

Recommended short-term monitoring practices include:

Vegetation evaluation—Systematic observations or sampling during the growing season for cover, yield, and/or species composition.

Climate records—Precipitation, temperature, etc. (This may be accomplished by summarizing available USDC weather records.)

Residue maps—Identification of areas where too much or too little grazing is occurring by mapping residual dry matter (RDM) at high, low, and moderate levels after livestock are removed from

pastures or during late September or early October.

Actual use records of livestock grazing—Livestock numbers, types and dates, animal condition score and/or weights (actual or estimated) in and out of pastures. The UC Cooperative Extension Pasture Inventory Program (George, Bell, and Lasarow 1987) can help you handle this information systematically.

Unplanned disturbances—Recording fires, wildlife use, insect and weed infestations, acts of vandalism, etc.

Long-term Monitoring

Long-term monitoring involves documenting measurements and observations for several years on study sites selected within the management area, grazing lease, pasture or areas of specific concern. Conducting measurements and/or observations over several years provides a trend. Site locations and types of data to be collected are determined by the management plan's objectives. Records must be carefully maintained, protected, and made available for planning.

A long-term monitoring program should include:

Trend transects—Systematic measurements (every 3 to 5 years) of the vegetation or other resource characteristics.

Trend photo points—Permanently established points at which photos are taken annually of a general view and one or more close-ups of important resource characteristics.

Aerial photos—Regularly scheduled photos of the same area to show major vegetation changes in brush, trees, and grasslands.

Sources:

- Lee MacDonald et al. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. EPA/910/9-91-001. May 1991.
- Monitoring California's Annual Rangeland Vegetation, UC/DANR Leaflet 21486, Dec. 1990.